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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

| | | | |
|---|----------|---------------|-----|
| Attorney Docket No. | LI30-001 | Total Pages | 125 |
| <i>First Named Inventor or Application Identifier</i> | | | |
| Fred A. Brown | | | |
| Express Mail Label No. | | EM156305213US | |

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)

2. Specification [Total Pages 25]
(preferred arrangement set forth below)

- Descriptive title of the Invention
- Cross References to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to Microfiche Appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings (if filed)
- Detailed Description
- Claim(s)
- Abstract of the Disclosure

3. Drawing(s) (35 USC 113) [Total Sheets 7]

4. Oath or Declaration [Total Pages 3]

- a. Newly executed (original or copy)
- b. Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 17 completed)
[Note Box 5 below]
 - i. DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).

5. Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
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6. Microfiche Computer Program (Appendix)

7. Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)

- a. Computer Readable Copy
- b. Paper Copy (identical to computer copy)
- c. Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. Assignment Papers (cover sheet & document(s))

9. 37 CFR 3.73(b) Statement Power of Attorney
(when there is an assignee)

10. English Translation Document (if applicable)

11. Information Disclosure Statement (IDS)/PTO-1449 Copies of IDS Citations

12. Preliminary Amendment

13. Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)

14. Small Entity Statement(s) Status still proper and desired

15. Certified Copy of Priority Document(s)
(if foreign priority is claimed)

16. Other:
.....
.....

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

 Continuation Divisional Continuation-in-part (CIP) of prior application No: _____

18. CORRESPONDENCE ADDRESS

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| | | | | | | |
|---------|---|-----------|----------------|-------|-----|----------------|
| NAME | DEEPAK MALHOTRA | | | | | |
| | Wells, St. John, Roberts, Gregory & Matkin P.S. | | | | | |
| ADDRESS | 601 West First, Suite 1300 | | | | | |
| | CITY | | Spokane | STATE | WA | ZIP CODE |
| COUNTRY | U.S.A. | TELEPHONE | (509) 624-4276 | | FAX | (509) 838-3424 |

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EK156305213

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR LETTERS PATENT

* * * * *

**METHODS OF INCREASING POWER HANDLING
CAPABILITY OF A POWER LINE**

* * * * *

INVENTOR

Fred A. Brown

ATTORNEY'S DOCKET NO. LI30-001

1 **METHODS OF INCREASING POWER HANDLING CAPABILITY OF**
2 **A POWER LINE**

3 **CROSS REFERENCE TO RELATED APPLICATIONS**

4 This application claims priority from U.S. Provisional application
5 60/036,021, filed January 31, 1997, titled "Nip and Tuck Power Line
6 Rerating Process", and incorporated herein by reference.

7

8 **TECHNICAL FIELD**

9 This invention relates to electrical power line re-rating of overhead
10 conductors using one or more of two possible modifications not
11 previously used for this purpose: removing small lengths of conductor,
12 and repositioning conductor support clamps. More particularly, this is
13 a process of determining and making the least cost adjustments to the
14 conductor system of a particular, existing overhead electrical power line
15 so as to allow the conductors in that line to operate at a higher
16 temperature than currently rated without violating safety codes, safety
17 clearances or design standards criteria for conductor sag and tension
18 using these possible modifications, separately or in combination with
19 each other. The intent of these modifications is to selectively increase
20 the tension in the conductor so as to eliminate clearance violations
21 caused by an increase in the sag of the conductor resulting from an
22 increase in the power transfer capability of the electrical power line.

BACKGROUND OF THE INVENTION

Electrical power line owners have a desire and need to transmit more power over existing power lines. As the amount of power being transmitted over a given line (conductor) increases, the temperature of the conductor increases. As the temperature of the conductor increases, the sag of the conductor increases. Existing weather conditions, conductor installation conditions and structural characteristics of the line also affect the amount of sag. Excess sag can put the conductor so close to objects on the earth as to cause flashover, which can damage the line and nearby facilities, cause power outages and endanger animal and plant life.

The current method for line re-rating is to combine sag and tension calculations with any one of a number of commercially available power line analysis computer programs, including longitudinal loading models, to calculate the maximum amperage or conductor temperature that can be used for that line which will not violate safety codes or clearance criteria, nor cause structural or conductor damage. If the desired or required conductor temperature cannot be achieved with the existing design, then the power line owner must resort to one or more of the standard current methods of eliminating the clearance violations. These standard methods include: re-conductoring, raising existing structures, re-tensioning the line between dead end sections, or inserting additional structures. The re-rating process may or may not include field verification of the physical parameters of the power line.

Inherent in any power line rating or re-rating process is the need to determine the behavior of the whole power line and individual conductors operating at higher temperatures. The behavior (sag) of the conductors at high temperatures is generally determined by computer programs, such as Alcoa's SAG10, that calculate the tension and corresponding sag of the conductor based on input of environmental parameters, conductor creep, temperature ranges and other factors. SAG10 is generally available and commonly used within the industry.

The behavior of the power line at high temperatures is determined by a longitudinal loading model. Longitudinal loading models calculate the position of the wire after a change in temperature or loading has occurred. The calculations in these models are based upon the length of wire in a span being fixed at a point in time with known environmental conditions (e.g., ambient temperature) and known geometry and physical characteristics (e.g., longitudinal movement of the conductor supports (insulators), type of conductor support, flexibility of the structures, relative elevation of conductor supports and the spans between structures). As the temperature or loading of the wire changes, the length of wire in that span changes based upon the geometry of the span and the physical properties of the wire, such as coefficient of thermal expansion and creep.

Presently, several procedures exist, used individually or in combination, to predict how much power can be transmitted over an

existing power line, under given environmental conditions, without violating safety codes or design standards.

1. The Institute of Electrical and Electronics Engineers (IEEE),
2. Electrical Power Research Institute (EPRI) and Power
3. Technologies Inc. (PTI) and others, have developed and modified
4. computer programs which calculate the electrical capacity (rating)
5. of a power line based upon thermodynamics and heat transfer
6. physics. These programs use environmental parameters, such as
7. wind speed, wind direction, ambient temperature, solar radiation
8. and line direction to calculate allowable amperage of a line.
9. "Worst case" environmental parameters are established and the
10. power line rating is calculated. These programs, used in
11. combination with a longitudinal load model or power line analysis
12. program establish the maximum amperage (or conductor
13. temperature) at which the line can be operated without violating
14. clearance criteria or damaging the conductor(s). Exceeding this
15. upper bound will very likely cause clearance violations, damage
16. the conductor, or both. The mathematical formulas found in the
17. power line rating programs are generally accepted within the
18. industry.
21. 2. Devices can be installed on the line to monitor the tension in
22. the conductor. Conductor tension is combined with other
23. environmental data, such as the ambient temperature and solar
24. radiation, to predict the rating or electrical capacity of the line.

1 Patent Nos. 5,517,864 and 5,235,861, both by Tapani O. Seppa
2 (and other patents noted therein), relate to methods of calculating
3 the approximate actual sag of an overhead power transmission line
4 by measuring the amount of tension on the line either by
5 tensiometers or swing angle indicators, as well as measuring
6 ambient temperature, both done at two different times, with no
7 power flow, and then remotely transmitting that information to a
8 computer for performance of calculations. From the data
9 received, a Ruling Span can be calculated from which to
10 determine a maximum safe current that can be transmitted by the
11 existing line without creating excess conductor sag.

12 3. Israel Electric Company, Haifa, Israel has occasionally used
13 selected algorithms to approximate actual sag under certain
14 combinations of conditions of weather, power transmission and
15 physical design; using basic longitudinal load modeling techniques.
16 4. Power Line Systems, Inc. is understood to have a computer
17 program (SagSec Software by Peyrot of Power Line Systems, Inc.
18 of Madison, WI) that performs a mathematical analysis of sag and
19 tension, using longitudinal load modeling, including allowance for
20 longitudinal insulator movement.
21 5. Multiple power line analysis, pole/tower spotting optimization,
22 profile analysis and display computer programs exist, including
23 TLCADD™, PLSCADD, and Optimal. These computer programs

1 are primarily used in the power line rating process to calculate
2 clearance to the conductors.

3 6. Current methods to increase the amount of power transmitted
4 over a given line generally require taking the line out of service
5 to make extensive modifications to the conductors or structures,
6 or both. An existing conductor can be replaced with a larger
7 conductor to allow the electrical line to carry an increased load.
8 Alternatively, structures in the existing line can be raised or
9 replaced to allow for the increased sag of the existing conductor
10 when carrying the higher electrical load. Also, new structures can
11 be installed between existing structures to eliminate the low
12 clearance areas caused by increased conductor sag.

13 The procedures of removing small lengths of conductor and of
14 sliding support clamps have been used in other contexts, but have not
15 been considered for the purpose of re-rating of power lines, as analysis
16 tools and procedures have not been available to perform the complex
17 calculations needed to determine where to make such removals or slide
18 such clamps.

1 **BRIEF DESCRIPTION OF THE DRAWINGS**

2 Preferred embodiments of the invention are described below with
3 reference to the following accompanying drawings.

4 Figs. 1, 1A are a logical flow chart of the re-rating process.

5 Fig. 2 is a graph illustrating how Figs. 2A-2C are assembled.

6 Figs. 2A-2C are a sample of the computer written output showing
7 where along the line a portion of a conductor should be removed, and
8 how much and in which direction to slip the support clamps.

9 Fig. 3 is a sample of the computer graphic output showing the
10 sag of the conductor under various conditions analyzed.

11 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

12 This disclosure of the invention is submitted in furtherance of the
13 constitutional purposes of the U.S. Patent Laws "to promote the
14 progress of science and useful arts" (Article 1, Section 8).

15 A portion of the disclosure of this patent document contains
16 material which is subject to copyright protection. The copyright owner
17 has no objection to the facsimile reproduction by anyone of the patent
18 document or the patent disclosure, as it appears in the Patent and
19 Trademark Office patent file or records, but otherwise reserves all
20 copyright rights whatsoever.

21 The purpose of this invention is to analyze, redesign and field
22 modify an existing electrical power line such that it will be able to
23 carry more power without violating clearance criteria, and without

1 necessarily having to change out the conductor, alter the structures or
2 de-energize the line (where energized line work is permissible and
3 economically advantageous), using the following two procedures,
4 separately or in combination with each other, to eliminate the clearance
5 violation:

- 6 1. Removing a length of conductor in the span with the clearance
7 violation, or in adjacent spans;
- 8 2. Adjusting the conductor support clamps on structure(s) adjacent
9 to or in the vicinity of the clearance violation.

10 In particular, this process includes:

- 11 1. A determination of whether removal of a portion of the conductor
12 is possible, and if so, how much and where to make such
13 removals;
- 14 2. A determination of whether adjusting the conductor support
15 clamps is possible, and if so, where and how much to move the
16 support clamps;
- 17 3. Estimations of the costs of making these adjustments and
18 modifications, as well as the costs of using standard procedures
19 now in practice;
- 20 4. A recommendation of the best combination of conductor
21 temperature, modification procedure and associated costs; and
- 22 5. Performing the actual modifications recommended.

Data is gathered (Fig. 1: Items 1, 2, and 3) from original design documentation and drawings, industry standards and field records. This data includes:

1. (Fig. 1:1) Meteorological conditions to be considered, especially: temperature ranges; wind velocities and directions; and anticipated ice loadings;
2. (Fig. 1:1) Clearance requirements, especially: above ground (Fig. 3:1); from edge of right-of-way; over special areas such as railroads, roadways, and fences;
3. (Fig. 1:1) Cost elements, especially: labor; construction equipment; structures and parts thereof; conductors; insulators; time to do certain types of tasks associated with re-rating lines; opportunity costs if the line must be de-energized to make alterations;
4. (Fig. 1:1) Conductor characteristics, especially: size; tensile strength; creep and stress characteristics over time and at various temperatures, including field measured unbalanced tensions; types and sizes of clamps needed;
5. (Fig. 1:3) Structure characteristics, especially: spacing between (Fig. 3:2); distances from edges of right-of-way; heights; weight bearing capacities (Fig. 3:4); flexibility (Fig. 3:4); insulator type, dimensions, length, swing, strength and field measured actual positions (Fig. 3:4); dead-end locations;

angle locations and actual line angles; attachment heights
(Fig. 3:3);

6. Terrain over which the line passes, especially: elevation (Fig.
3:5); width of right-of-way; and special features.

Profile drawings are scanned and digitized using commercially available drafting programs (Fig. 1:4).

All of the data collected is loaded into complete, formatted databases for use in, and as required by, commercially available engineering profile analysis and display programs, such as TLCADD (Fig. 1:5). This data is used for the following calculations.

From the data collected, and using a longitudinal loading model, a preliminary analysis of the power line is performed to evaluate the quality of data collected and identify the problem spans (Fig. 1:5A). Based upon the preliminary evaluation, a detailed visual inspection and detailed survey may be undertaken (Fig. 1:3) to improve the quality of the input data and analysis.

Structural analysis is made of all structures to determine maximum strength and flexibility, using standard, commercially available structural analysis programs, such as STAAD-III, by Research Engineers, Inc.

Conductors are analyzed to determine maximum available strength, sag and creep characteristics, using standard, commercially available conductor sag and tension analysis programs, such as Alcoa's "SAG10".

A best fit, or "Base Case", computer model of the line is developed to accommodate all the existing data of the line section. This includes plan and profile data, adjusted by field surveys of spans, sags, significant insulator offsets and pole deflections all at the base case temperature.

A "Trial A" is then calculated using a longitudinal loading model analysis (Fig. 1:6). This base case shows what would happen to the conductors if operated at the maximum desired operating temperatures without modification. The multiple-iteration analysis is calculated on a span-by-span basis, considering: span length, weight span, catenaries in each span, insulator swing, insulator weight and stiffness, all to analyze the line under very high temperature (VHT) conditions without the errors introduced by the standard Ruling Span concept.

In this process, the catenary shapes of the wire in each span must be accurately determined for various conductor conditions, such as maximum desired temperature, and wind and ice loadings of the line under normal conditions. This is done through multiple iterations of the calculations in the longitudinal loading model.

From such analysis, clearance violations are identified on an individual span by span basis. This is generally done with a commercially available power line analysis spotting optimization program, such as TLCADD, taking into account the movement of insulator strings and individual structure stiffness.

1 Also as part of this process (Fig. 1:6), the critical spans (spans
2 with clearance violations) created by higher conductor operating
3 temperatures are noted. The nature and severity of each clearance
4 violation is noted.

5 a) This invention considers two methods for eliminating the clearance
6 violation in the critical spans, which methods have not previously been
7 used for this purpose. Each of these methods are considered and the
8 resultant line characteristics, on a span-by-span basis, are determined;
9 again, through multiple iterations of the longitudinal loading model.
10 While hand calculations are possible, use of a computer program or
11 other automated procedure will greatly assist the designer with these
12 multiple iteration calculations. It is necessary to analyze each span
13 separately, considering a virtually infinite number of combinations of how
14 much and where to either cut out pieces of the conductor, or to slide
15 the clamps, or some combination of both, over a several span section
16 of the system.

17 b) Each span must be separately analyzed in order to overcome the
18 errors inherent in the commonly used "Ruling Span" concept. With a
19 change in the length of the wire, there is a corresponding change in
20 the wire tension. To achieve equilibrium at the conductor support
21 points at either end of the span, the insulators and, to a lesser degree,
22 the structures, move to balance the forces in the adjacent spans. The
23 formulae for calculating the change in the length of the wire and the
24 corresponding change in tension are commonly available within the

1 industry; see, for example, Southwire Company, Overhead Conductor
2 Manual, First Edition, 1994.

3 c) The movement of the insulators is determined by resolving the
4 forces in a static equilibrium calculation. Since the movement of each
5 insulator is affected by the adjacent spans, mathematically determining
6 the equilibrium points of a multi-span wire system requires multiple
7 calculations in an iterative process. Wire systems larger than two to
8 four spans may require hundreds of calculations in multiple iterations.
9 The availability of commercially available computer programs, such as
10 "SagSec" (by PLS) or "Nip & Tuck" (by ECSI), will speed the
11 calculation process to the point of practicality.

12 d) Removing a small piece of the conductor increases the tension,
13 which will cause the insulators to move so that equilibrium at the
14 insulator is maintained. Since this insulator movement affects the
15 tension in the adjacent spans, an iterative solution is required to find
16 what the equilibrium point is for each of the affected spans. A similar
17 process occurs when the position of the support clamps is changed. By
18 doing so, the length of wire in two spans are changed, which changes
19 the tension in at least three spans, which will cause the insulators on
20 each end of the spans affected to move to new equilibrium positions.
21 Again, for a multi-span line section, this will require multiple iterations.

22
23 In performing these analyses, the designer considers:

24 1. the initial position of the insulators and conductor;

- 1 2. the change in tension in the conductor at each span;
- 2 3. the position on the conductor where the support clamps
- 3 should be reattached;
- 4 4. vibration limits on the line and structures (Fig. 1:8);
- 5 5. maximum tension capabilities of all components (Fig. 1:8);
- 6 6. flexibility of the structures;
- 7 7. insulator swing at each structure (Fig. 1:8);
- 8 8. resultant load applied to each structure (Fig. 1:8); and
- 9 9. the resultant actual catenaries at various temperature and
- 10 conductor loadings (Fig. 1:7)

11
12 The designer will need to use best practice as judgment to
13 determine the true practical feasibility of the recommendations from the
14 first analysis, for removal of pieces of the conductor and movement of
15 clamps at various structure locations, and develop an optimal solution.

16 A display of the results might look like Figure 2. In this
17 example, the "Trial B" section indicates a need to remove 1.75 feet
18 between 29 and 30 (Fig. 2:1) and a removal of 2.25 feet between
19 structures 22 and 23 (Fig. 2:2). Trial B also recommends a movement
20 of the clamp at structure 30 backwards by .25 feet (Fig. 2:3), and
21 movement of the clamps at structure 29 ahead .25 feet (Fig. 2:4), as
22 well as a backwards movement of the clamp at structure 23 by .25 feet
23 (Fig. 2:5).

1 "Trial B" is used to verify the sag clearances and insulator
2 deflections at the preferred very high temperature (VHT) operation
3 assuming the corrections introduced, as reflected in the Trial B columns
4 marked "Removal" (Fig. 2:6) and "Shift" (Fig. 2:7). As there are
5 potentially an unlimited number of different options regarding the
6 application of the procedures, this "Trial B," may be repeated several
7 times to optimize the cost and find feasible solutions on a difficult
8 section of line. The optimization is usually focused on minimizing the
9 number of field operations, that is minimizing the number of pieces of
10 the conductor to remove and the number of clamp movements. Such
11 things as insulator deflection, longitudinal loading, conductor vibration,
12 uplift, construction access, construct-ability, and energized versus de-
13 energized must also be considered and evaluated by the engineer (Fig.
14 1:8).

15 The cost of these procedures, used separately or in conjunction
16 with each other, is calculated and compared to the costs for the
17 standard alternatives (Fig. 1:9).

18 Using standard engineering procedures, construction estimates are
19 prepared for various standard design modification alternatives (Fig. 1:9).
20 The engineer should include such other standard modification possibilities
21 as:

22 1. Putting in all new conductor with more power
23 transmission ability; including replacement of components not
24 currently capable of bearing the additional stresses imposed by

1 new conductor. These components may include poles/towers,
2 crossarms, braces, bolts, insulators and other structural
3 components;

4 2. Increasing the height of some structures;

5 3. Increasing the number of structures;

6 4. Re-sagging: putting the whole line or line segment, from
7 dead end to dead end, in sheaves, pulling it tighter at a fixed
8 location, allowing the line to seek its own sag 'level', then re-
9 clamping; and

10 5. Attempting to do some or all of the field modifications
11 with the power line energized.

12
13 In the event the costs of all alternatives are higher than
14 allowable, a recommendation of a lower operating temperature, with
15 calculations made of how much the line could be altered, under the
16 lowest cost alternative, and a determination is made of how much the
17 operating temperature of the conductor could be increased given that
18 level of alteration (Fig. 1:9).

19 Figure 3 is an example of a graphic output from a commercially
20 available computerized longitudinal loading analysis program showing, in
21 this case, two structures (Fig. 3:7), their station numbers or distance
22 along the line (Fig. 3:6), the sag in the conductor at normal maximum
23 operating temperature and conditions (Fig. 3:8), the expected sag in the
24 line if operated at maximum desired temperature without modification

1 (Fig. 3:9), and the sag in the line at the higher operating temperature
2 desired and after the determined optimal modification (Fig. 3:10). This
3 is the image that would be used as the final overlay in comparison
4 (Fig. 1:13).

5 Once a preferred field modification plan is determined, and client
6 approval obtained (Fig. 1:14), then construction drawings and
7 specifications are prepared (Fig. 1:11). A report is prepared for the
8 construction forces (Fig. 1:10). This describes, in order, precisely where
9 and how much conductor to remove and which clamps to move, how
10 far and which direction.

11 The power line conductor(s) is then physically altered by making
12 the cuts and resetting the clamps as prescribed by the process. The
13 actual field modifications to the conductor are an integral part of the
14 invention as the construction process is only possible with the
15 invention's detailed construction specifications (Fig. 1:12). Standard
16 construction techniques would be used for the actual cutting and splicing
17 of the conductors, and the loosening, sliding and tightening of clamps.

18 In compliance with the statute, the invention has been described
19 in language more or less specific as to structural and methodical
20 features. It is to be understood, however, that the invention is not
21 limited to the specific features shown and described, since the means
22 herein disclosed comprise preferred forms of putting the invention into
23 effect. The invention is, therefore, claimed in any of its forms or

1 modifications within the proper scope of the appended claims
2 appropriately interpreted in accordance with the doctrine of equivalents.
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1 **CLAIMS:**

2 1. A method of increasing the power handling capability of a
3 power line, the method comprising:

4 providing a conductor configured to transmit energy intermediate
5 plural locations;

6 supporting the conductor at a plurality of positions intermediate
7 the locations, the supporting at a plurality of positions defining a
8 plurality of spans of the conductor;

9 creating a model of the conductor;

10 identifying a critical span;

11 altering the modelled conductor responsive to the identifying; and
12 analyzing the modelled conductor following the altering.

13

14 2. The method according to claim 1 further comprising
15 analyzing the modelled conductor at an increased operating condition
16 and the identifying being responsive to the analyzing the modelled
17 conductor at the increased operating condition.

18

19 3. The method according to claim 1 further comprising
20 supporting the conductor using a plurality of clamps.

1 4. The method according to claim 3 wherein the altering the
2 modelled conductor includes at least one of removing a portion of the
3 modelled conductor and adjusting the positioning of one of the clamps
4 within the modelled conductor.

5
6 5. The method according to claim 1 further comprising
7 identifying another critical span responsive to the analyzing.

8
9 6. The method according to claim 5 further comprising
10 repeating the altering and analyzing following the identifying the another
11 critical span.

12
13 7. The method according to claim 1 further comprising
14 optimizing including repeating the altering and the analyzing.

15
16 8. The method according to claim 1 wherein the analyzing
17 comprises using a digital computer.

1 9. A method of increasing power handling capability of a
2 power line, the method comprising:

3 providing a conductor configured to transmit energy intermediate
4 plural locations;

5 supporting the conductor using a plurality of clamps; and

6 altering the conductor including at least one of removing a
7 portion of the conductor and adjusting the positioning of one of the
8 clamps relative to the conductor.

9
10 10. The method according to claim 9 further comprising:

11 creating a model of the conductor;

12 analyzing the modelled conductor at an increased operating
13 condition; and

14 identifying a critical span responsive to the analyzing.

15
16 11. The method according to claim 10 wherein the altering is
17 responsive to the identifying.

18
19 12. The method according to claim 10 further comprising:

20 altering the modelled conductor following the identifying; and

21 analyzing the modelled conductor following the altering of the
22 modelled conductor.

1 13. The method according to claim 12 further comprising
2 optimizing including repeating the altering and the analyzing of the
3 modelled conductor.

4

5 14. A method of increasing the power handling capability of a
6 power line, the method comprising:

7 providing a conductor configured to transmit energy intermediate
8 plural locations;

9 creating a model of the conductor;

10 first analyzing the modelled conductor at an increased operating
11 condition;

12 identifying a critical span responsive to the first analyzing;

13 altering the modelled conductor responsive to the identifying; and
14 second analyzing the modelled conductor following the altering.

15

16 15. The method according to claim 14 wherein the first
17 analyzing comprises analyzing the modelled conductor at a maximum
18 operating temperature.

19

20 16. The method according to claim 14 wherein the first and
21 second analyzings individually comprise using a digital computer.

22

23 17. The method according to claim 14 further comprising
24 supporting the conductor using a plurality of clamps.

1 18. The method according to claim 17 wherein the altering
2 includes at least one of removing a portion of the modelled conductor
3 and adjusting the positioning of one of the clamps within the modelled
4 conductor.

5

6 19. The method according to claim 14 further comprising:
7 identifying another critical span responsive to the second analyzing;
8 and

9 altering the modelled conductor following the identifying another
10 critical span.

11

12 20. The method according to claim 14 further comprising
13 optimizing including repeating the altering and the second analyzing.

1 **ABSTRACT OF THE DISCLOSURE**

2 The present invention includes methods of increasing the power
3 handling capability of a power line. One method of the present
4 invention includes providing a conductor configured to transmit energy
5 intermediate plural locations; supporting the conductor at a plurality of
6 positions intermediate the locations, the supporting at a plurality of
7 positions defining a plurality of spans of the conductor; creating a
8 model of the conductor; identifying a critical span; altering the modelled
9 conductor responsive to the identifying; and analyzing the modelled
10 conductor following the altering.

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DECLARATION OF SOLE INVENTOR FOR PATENT APPLICATION

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated
below next to my name.

I believe I am the original, first and sole inventor of the subject
matter which is claimed and for which a patent is sought on the
invention entitled: METHODS OF INCREASING POWER HANDLING
CAPABILITY OF A POWER LINE.

I hereby state that I have reviewed and understand the contents
of the above-identified specification, including the claims.

I acknowledge the duty to disclose information known to me to
be material to patentability as defined in Title 37, Code of Federal
Regulations §1.56.

PRIOR PROVISIONAL APPLICATIONS:

I hereby claim the benefit under 35 U.S.C. §119(e) of U.S.
Provisional Application Serial No. 60/036,021, titled NIP AND TUCK
POWER LINE RERATING PROCESS, and filed January 31, 1997.

PRIOR FOREIGN APPLICATIONS:

I hereby state that no applications for foreign patents or inventor's
certificates have been filed prior to the date of execution of this
declaration.

1 **POWER OF ATTORNEY:**

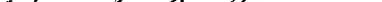
2 As a named Inventor, I hereby appoint the following attorneys and
3 agent to prosecute this application and transact all business in the
4 Patent and Trademark Office connected therewith: Richard J. St. John,
5 Reg. No. 19,363; David P. Roberts, Reg. No. 23,032; Randy A. Gregory,
6 Reg. No. 30,386; Mark S. Matkin, Reg. No. 32,268; James L. Price, Reg.
7 No. 27,376; Deepak Malhotra, Reg. No. 33,560; Mark W. Hendrickson,
8 Reg. No. 32,356; David G. Latwesen, Reg. No. 38,533; George G.
9 Grigel, Reg. No. 31,166; Keith D. Grzelak, Reg. No. 37,144; John S.
10 Reid, Reg. No. 36,369; Lance R. Sadler, Reg. No. 38,605; and James D.
11 Shaurette, Reg. No. 39,833.

12 Send correspondence to: WELLS, ST. JOHN, ROBERTS,
13 GREGORY & MATKIN P.S., 601 W. First Avenue, Suite 1300, Spokane,
14 WA 99201-3817. Direct telephone calls to: James D. Shaurette
15 (509) 624-4276.

16 I hereby declare that all statements made herein of my own
17 knowledge are true and that all statements made on information and
18 belief are believed to be true; and further that these statements were
19 made with the knowledge that willful false statements and the like so
20 made are punishable by fine or imprisonment, or both, under
21 Section 1001 of Title 18 of the United States Code and that such willful
22 false statement may jeopardize the validity of the application or any
23 patent issued therefrom.

* * * * *

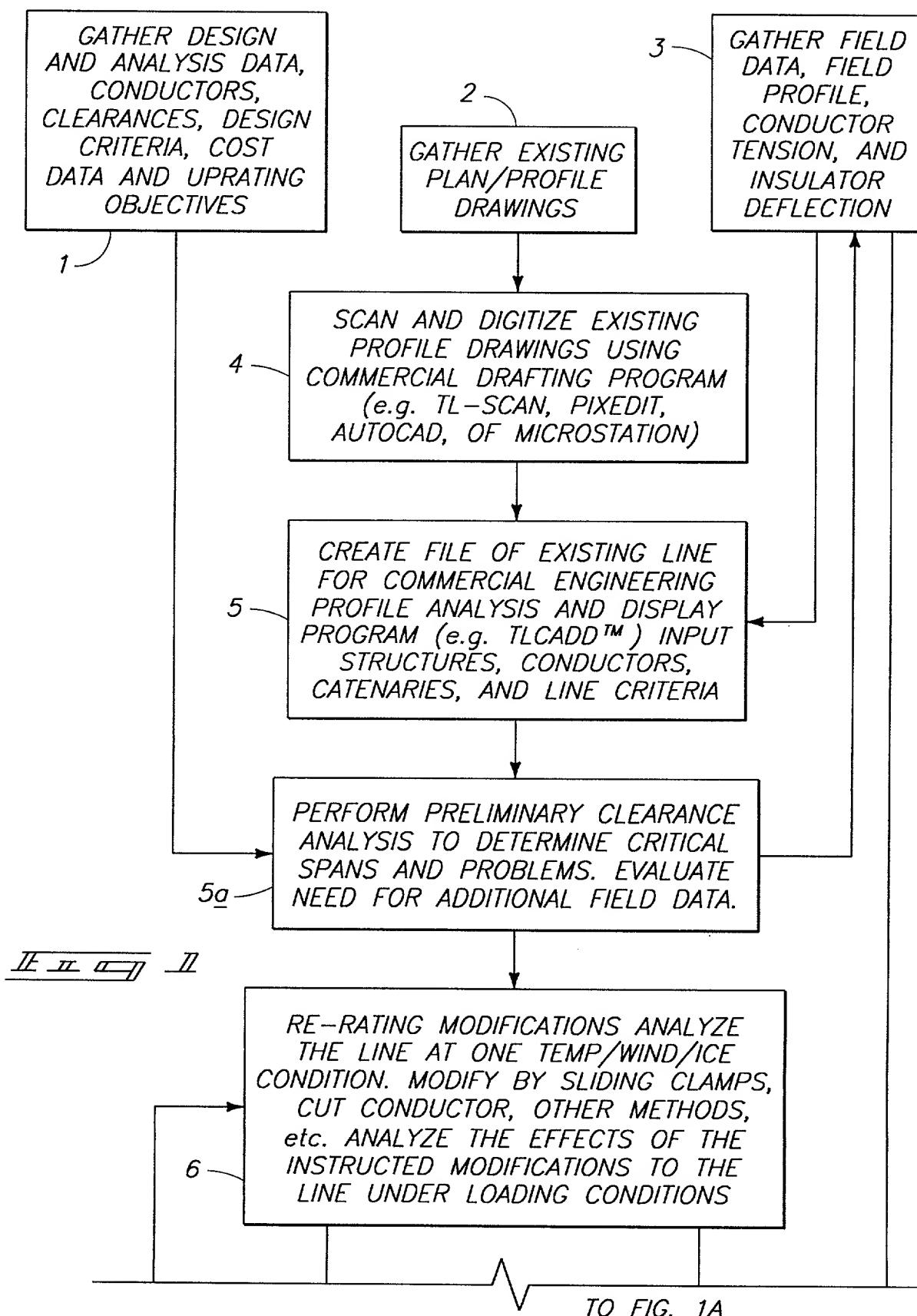
2 Full name of sole inventor: **Fred A. Brown**

3 Inventor's Signature: 

4 Date: January 23, 1998

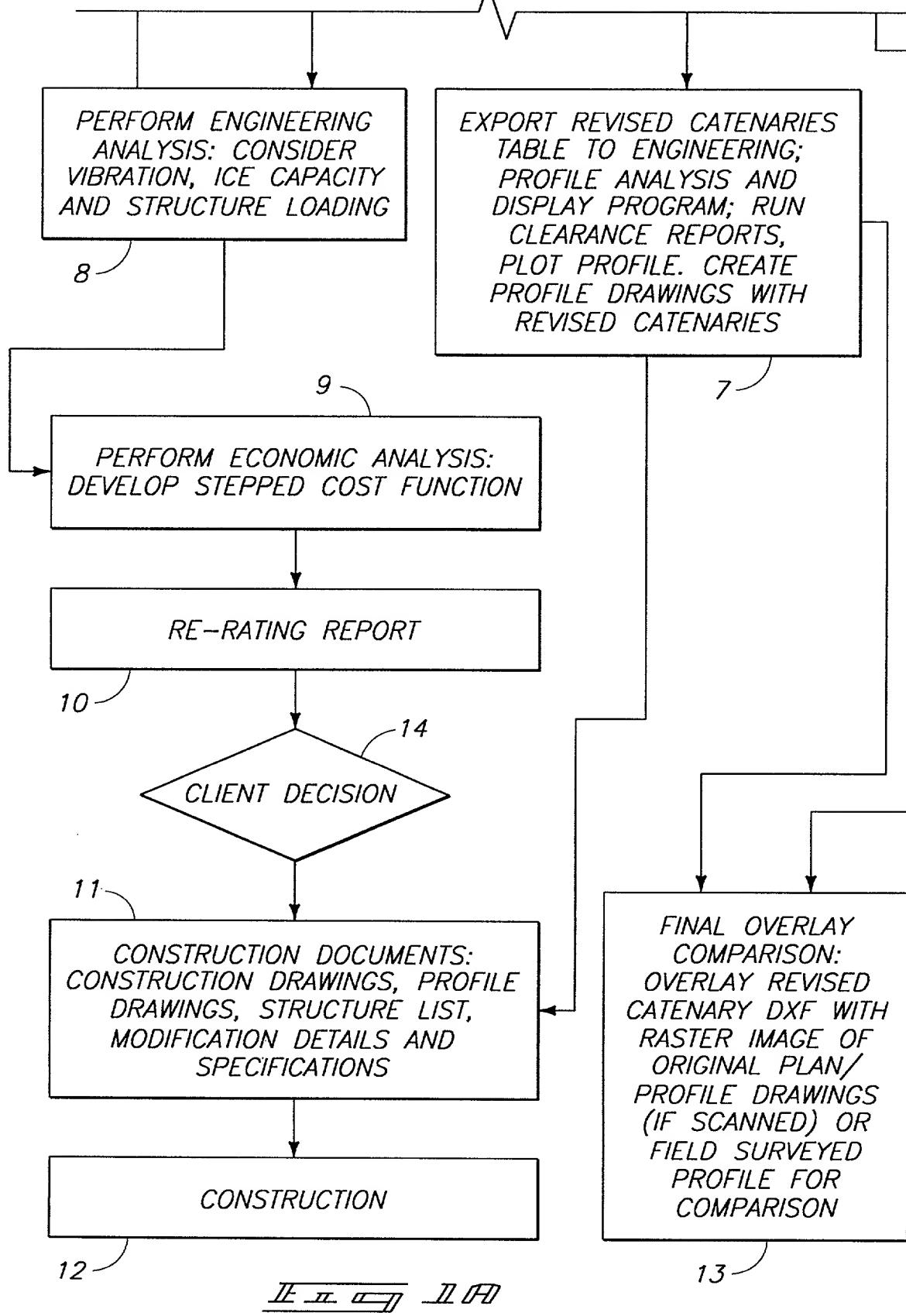
Post Office Address: 9215 N. Palmer Rd., Spokane, WA 99207

1/7

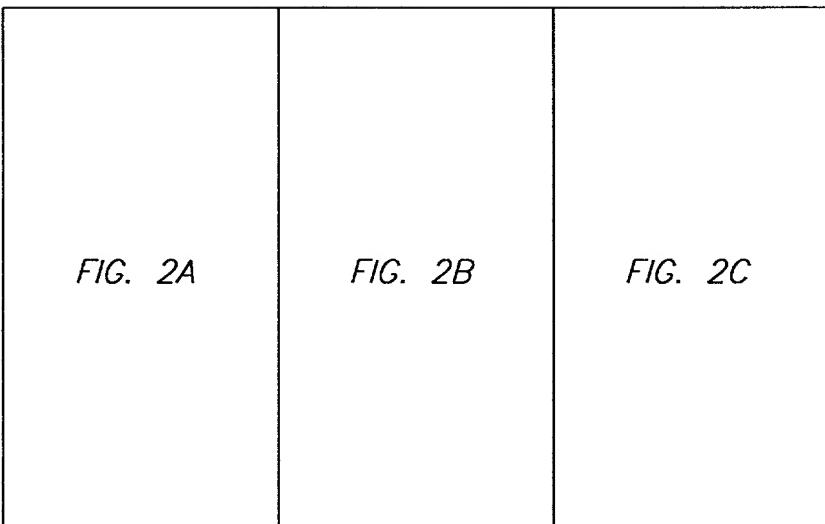


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FROM FIG. 1

EE II EE II MM

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IF II APP APP

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| STATION | STR | LINE ANGLE | SPAN | DEFLECT | SAG | C |
|--|-----|------------|--------|---------|--------|------|
| <i>BASE CASE 60 DEG. F TENSION = 3400LB.</i> | | | | | | |
| 3707 | 36 | 82.1 | | 0.000 | | |
| | | | 993.0 | | 19.818 | 6219 |
| 4700 | 35 | 0 | | 0.000 | | |
| | | | 775.0 | | 12.071 | 6220 |
| 5475 | 34 | 0 | | 0.000 | | |
| | | | 925.0 | | 17.196 | 6220 |
| 6400 | 33 | 0 | | 0.000 | | |
| | | | 825.0 | | 13.679 | 6220 |
| 7225 | 32 | 0 | | 0.000 | | |
| | | | 875.0 | | 15.387 | 6220 |
| 8100 | 31 | 0 | | 0.000 | | |
| | | | 875.0 | | 15.387 | 6220 |
| 8975 | 30 | 0 | | 0.000 | | |
| | | | 925.0 | | 17.196 | 6220 |
| 9900 | 29 | 0 | | 0.000 | | |
| | | | 925.0 | | 17.196 | 6220 |
| 10825 | 28 | 0 | | 0.000 | | |
| | | | 919.7 | | 17.001 | 6219 |
| 11744.7 | 27 | -11.48 | | 0.000 | | |
| | | | 830.3 | | 13.855 | 6220 |
| 12575 | 26 | 0 | | 0.000 | | |
| | | | 825.0 | | 13.679 | 6219 |
| 13400 | 25 | 0 | | 0.000 | | |
| | | | 675.0 | | 9.157 | 6220 |
| 14075 | 24 | 0 | | 0.000 | | |
| | | | 900.0 | | 16.279 | 6220 |
| 14975 | 23 | 0 | | 0.000 | | |
| | | | 975.0 | | 19.105 | 6220 |
| 15950 | 22 | 0 | | 0.000 | | |
| | | | 750.0 | | 11.305 | 6220 |
| 16700 | 21 | 0 | | 0.000 | | |
| | | | 1000.0 | | 20.098 | 6220 |

II II II

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| | TRIAL A REMOVAL | TRIAL A SHIFT | TRIAL A DEFLECT | TRIAL A SAG | TRIAL A C |
|--------------------|--------------------|------------------|--------------------|----------------|--------------|
| TRIAL A 212 DEG. F | | | | | |
| | | | 0.000 | | |
| | | | | 31.434 | 3919 |
| | | | -0.245 | | |
| | | | | 19.445 | 3863 |
| | | | 0.003 | | |
| | | | | 27.675 | 3864 |
| | | | -0.099 | | |
| | | | | 22.153 | 3842 |
| | | | 0.033 | | |
| | | | | 24.873 | 3848 |
| | | | 0.052 | | |
| | | | | 24.814 | 3857 |
| | | | 0.081 | | |
| | | | | 27.607 | 3873 |
| | | | -0.010 | | |
| | | | | 27.634 | 3870 |
| | | | -0.104 | | |
| | | | | 27.499 | 3844 |
| | | | -0.213 | | |
| | | | | 22.676 | 3801 |
| | | | -0.130 | | |
| | | | | 22.554 | 3773 |
| | | | -0.062 | | |
| | | | | 15.154 | 3762 |
| | | | 0.267 | | |
| | | | | 26.555 | 3812 |
| | | | 0.177 | | |
| | | | | 30.833 | 3852 |
| | | | -0.104 | | |
| | | | | 18.366 | 3831 |
| | | | 0.163 | | |
| | | | | 32.300 | 3867 |

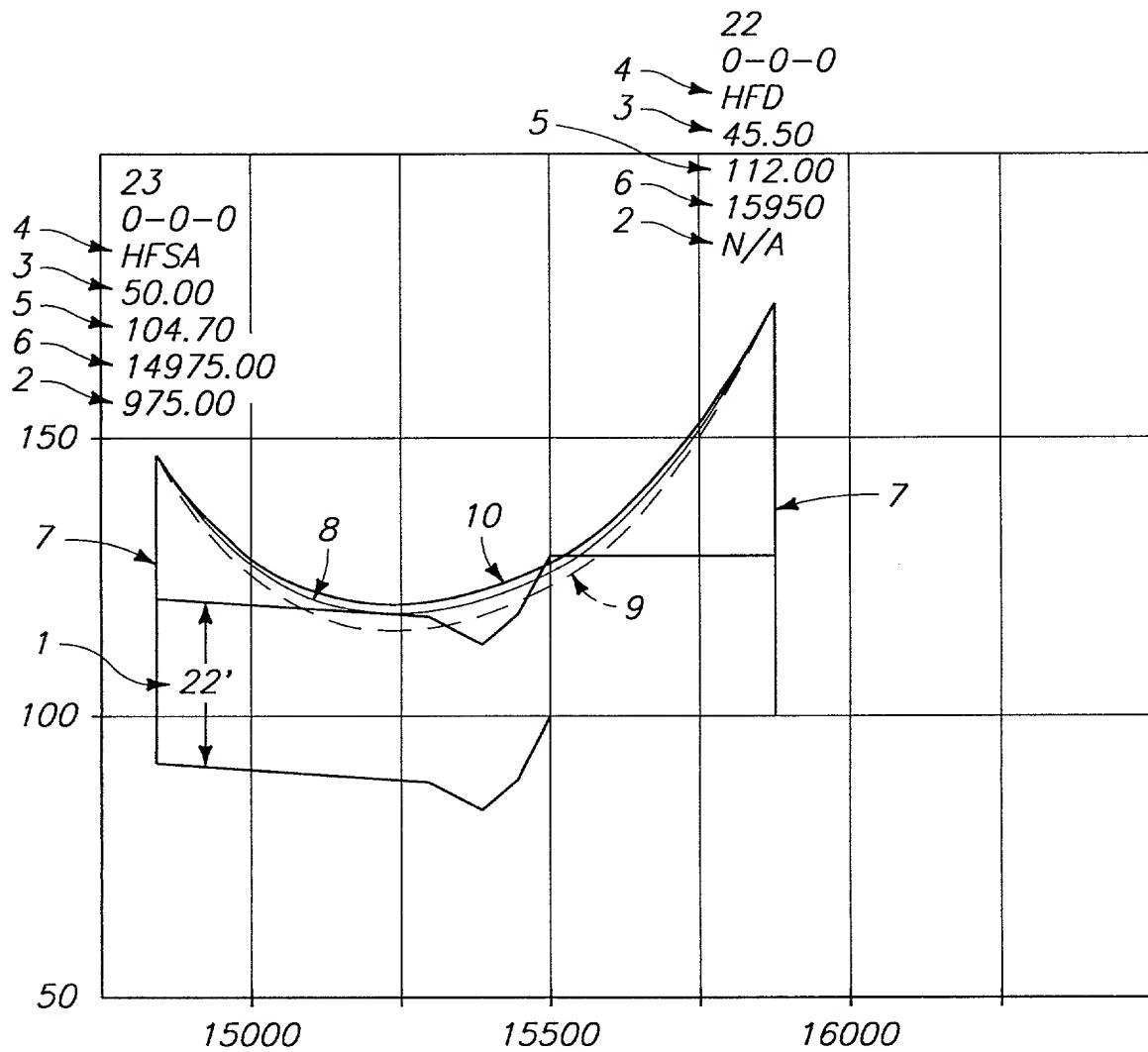
EE E P P BB

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| | TRIAL B REMOVAL | TRIAL B SHIFT | TRIAL B DEFLECT | TRIAL B SAG | TRIAL B C |
|--------------------------|--------------------|------------------|--------------------|----------------|--------------|
| TRIAL B 212 DEG. F W/N&T | | | | | |
| | | 0 | 0.000 | | |
| | 0 | | | 29.940 | 4115 |
| | | -0.25 | -0.229 | | |
| | 0 | | | 18.512 | 4062 |
| | | 0 | 0.411 | | |
| | 1 | | | 25.781 | 4141 |
| | | 0 | -0.374 | | |
| | 0 | | | 21.008 | 4058 |
| | | 0.5 | 0.442 | | |
| | 0 | | | 23.066 | 4147 |
| | | 0 | 0.253 | | |
| | 0 | | | 22.797 | 4199 |
| | 1 | | -0.25 | 0.359 | |
| | 1.75 | | 4 | 24.968 | 4275 |
| | | 0.25 | -0.544 | | |
| | 0 | | | 25.817 | 4147 |
| | | 0.5 | -0.079 | | |
| | 0 | | | 25.598 | 4128 |
| | | 0 | -0.368 | | |
| | 0 | | | 21.279 | 4053 |
| | | 0 | -0.064 | | |
| | 0 | | | 21.078 | 4039 |
| | | 0 | 0.239 | | |
| | 0 | | | 13.972 | 4082 |
| | | 0 | 0.728 | | |
| | 0 | | 5 | 24.013 | 4217 |
| | 2 | | -0.25 | 0.810 | |
| | 2.25 | | | 26.920 | 4400 |
| | | 0 | -0.800 | | |
| | 0 | | | 16.638 | 4232 |
| | | 0 | -0.283 | | |
| | 0 | | | 29.970 | 4171 |

II II SW SW

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EE EE EE

EX-1 - 2013

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor Fred A. Brown
Attorney's Docket No. LI30-001
Title: Methods of Increasing Power Handling Capability of a Power Line

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) and 1.27(c)) - SMALL BUSINESS CONCERN

I hereby declare that I am

the owner of the small business concern identified below:
 an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: ECSI Corporation

ADDRESS OF CONCERN: 2314 N. Cherry St., Spokane, WA 99216

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled Methods of Increasing Power Handling Capability of a Power Line.

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e). *Note: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME:

ADDRESS:

Individual

Small Business Concern

Nonprofit Organization

NAME:

ADDRESS:

Individual

Small Business Concern

Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Name of Person Signing Ron J. Carrington

Title of Person Other Than Owner Engineering Manager

Address of Person Signing 2314 N. Cherry Street, Spokane WA 99216

Signature Ron J. Carrington Date 1/27/98